



2018 DOE Vehicle Technologies Office Annual Merit Review Presentation

**“Next Generation Intelligent Traffic Signals for the
Multimodal, Shared, and Automated Future”**

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Project ID: eems069

+ Overview

Timeline:

- Project start date: July 2018
- Project end date: July 2019
- Percent complete: 75%

Budget:

- Total project funding: \$150,000

Partners:

- Argonne National Laboratory
- City of Greenwood Village, CO
- City of Fremont, CA
- Colorado Dept of Transportation
- Los Angeles Cleantech Incubator

Barriers:

- Real-world validation required of “proportionally fair” Adaptive Traffic Control System (ATCS) algorithm.
- Connected and Automated Vehicle Future requires vehicle to infrastructure (V2I) capable ATCS algorithm design.
- Computational difficulty of modeling energy efficiency and greenhouse gas (GHG) improvements across cities.

+ Relevance

- Real-world, in-street research of Proportionally Fair Adaptive Traffic Control System (ATCS) algorithm to continuously retune traffic signals. Previously achieved a **50% throughput increase** in PTV VISSIM microsimulation
 - Prepare algorithm for real-world inputs (induction loops, video, etc).
 - Design system to communicate with in-road traffic signal controllers
 - Deploy in live intersections, collect baseline and live data
 - Conduct pre/post data analysis with ANL to validate energy efficiency gain of vehicles on associated streets (initial estimate by ANL = **15% energy efficiency gain** and proportional greenhouse gas emissions reduction)
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- Achieved:
 - Algorithm prepared and implemented
 - System interface with real signal controllers completed
 - Bench test completed, deployed in live intersections
 - Pending:
 - Project ends 7/1/2019. Results pending; verbal update available during VT AMR poster review

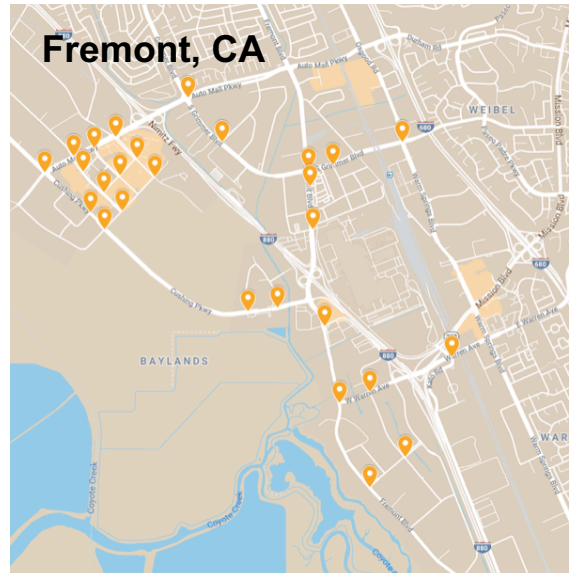
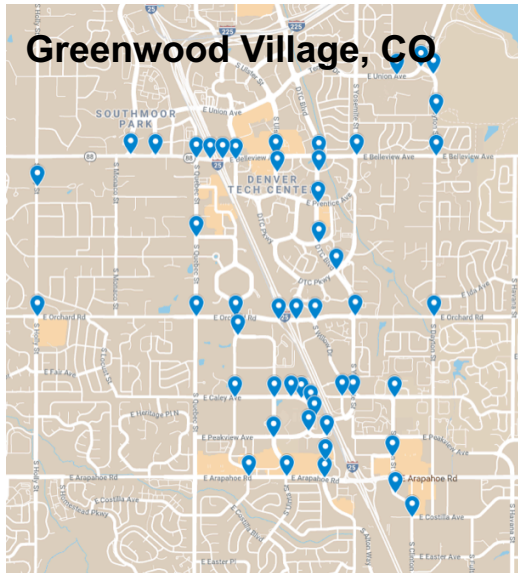
+ Milestones

Milestones + Go/No-go (12 month period of performance)	Q1	Q2	Q3	Q4	Responsible Party
Objective 1: Algorithm programming for real-world application					Xtelligent
Objective 2: System integration into traffic signal controllers					Xtelligent
Objective 3: Bench testing in live signal controllers					Xtelligent
Objective 4: Research deployment in city intersections					Xtelligent
Objective 5: Data evaluation of beta/pilot					Xtelligent/ANL

+ Approach

Overview:

- Xtelligent is **deploying in live traffic intersections** a novel ATCS algorithm inspired by IT network control theory.
- The system seeks to maximize vehicular throughput.
- This complex project requires coordination with city public works departments, city IT network administrators, signal controller manufacturers, and existing vehicle detection sensors
- The overarching goal is **real-world validation** of PTV VISSIM simulation results suggesting throughput increases of 50% or greater are possible



+ Technical Accomplishments and Progress

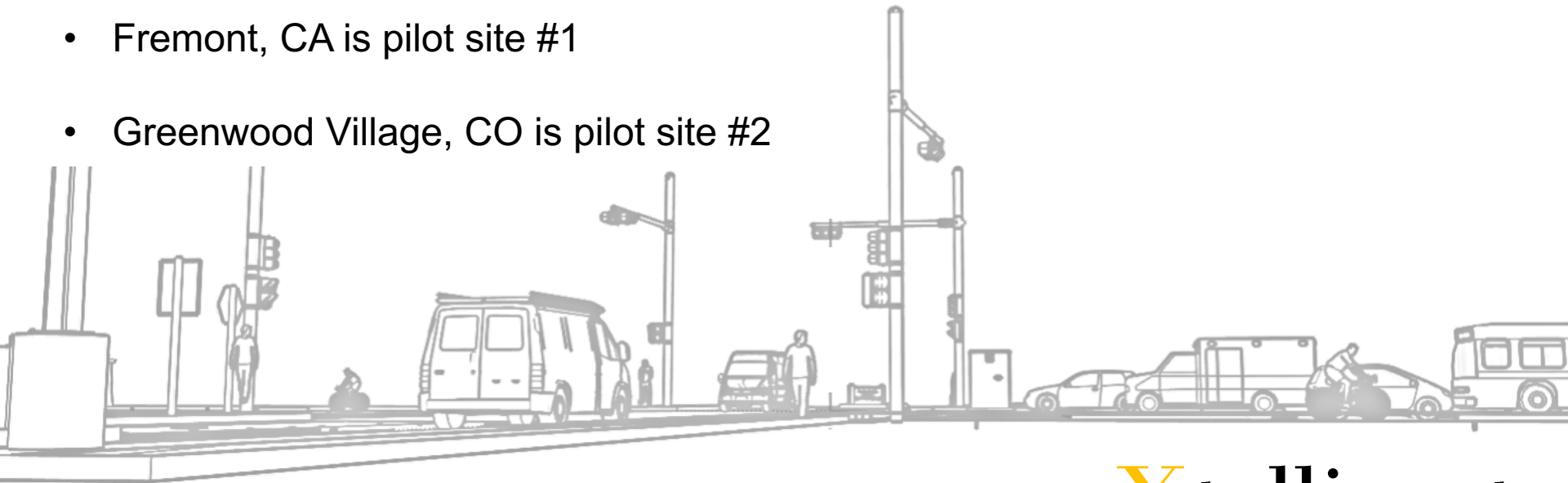
Milestone	Accomplishment/status
1: Algorithm programming for real-world application	Adapted algorithm inputs for use with in-street vehicle sensors, some alternate intersection geometries, and city IT network requirements.
2: System integration into traffic signal controllers	Updated software to work with existing traffic signal controllers at pilot sites.
3: Bench testing in live signal controllers	Successfully conducted safety and functionality bench tests with city traffic engineers to gain approval for ATCS activation on live streets.
4: Research deployment in city intersections	Deployed into two urban networks, began ATCS activation.
5: Data evaluation of beta/pilot	In progress. Project ends 7/1/2019. Verbal update available during VT AMR poster review session.

+ Responses to Previous Year's Reviewer Comments

Project was not reviewed at least year's AMR review

+ Collaboration and Coordination with Other Institutions

- Project requires complex collaboration with city engineers, city IT network administrators, and traffic signal controller manufacturers.
- Argonne National Laboratory is a subcontractor for final data analysis to estimate energy efficiency gains achieved by this ATCS approach as well as corresponding GHG emissions reductions.
- Fremont, CA is pilot site #1
- Greenwood Village, CO is pilot site #2



+ Remaining Challenges and Barriers

- High variability across city intersections adds considerable cost and complexity to pilot studies
- Reliability of in-street vehicle detection (induction loops, video, etc.) is low
- Quality of in-street vehicle detection data is low
- Small deployments limit potential results.

+ Proposed Future Research

Current plans:

- Project is currently in its final phase and is scheduled to conclude on 7/1/2019.
- ATCS activation is in-progress
- Pre/post baselining and performance data will be analyzed by the project team and also supplied to ANL for advanced simulation in June.

Future research:

- The time, complexity, and expense of real-world ATCS preparation and implementation is considerably larger than a Phase I SBIR.
- With additional time and funding, deployment should be increased to a larger urban environment, and additional vehicle location data sources utilized.

“Any proposed future work is subject to change based on funding levels.”

+ Summary

- Xtelligent has made significant progress and is currently performing ATCS activation of its novel optimization algorithm.
- Results are still pending and are expected to be available by 7/1/2019
- Argonne National Laboratory will extrapolate real-world pilot data across an entire metropolis in its Autonomie simulator, and supply estimated energy efficiency gains and GHG reduction.